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WMO Workshop on Climate Monitoring including the Implementation of a Climate Watch System in RA I with focus on eastern and southern Africa

(Pretoria, South Africa, 15–18 April 2013)

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WMO workshop on Climate Monitoring including the implementation of Climate Watch Systems in RA I with focus on eastern and southern Africa

15 – 18 April 2013
Swanlake Hotel
Pretoria, South Africa

Proceedings

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Concept note

Rationale

In recent decades, climate variability and climate extremes have resulted in increasingly noticeable impacts on societies in countries throughout the world. The IPCC 4th Assessment Report states: ''Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones."

With regards to climate and weather related extremes, WMO through its various programs works with its Members to help countries to make the transition from "crisis management" policies to "risk assessment/risk management" policies and considers that it is important that information on the state of the climate is provided to relevant decision-making organizations, such as governments, agricultural agencies, emergency management services, and water resource management agencies.

A Climate Watch is delivered as an alert/advisory on foreseen and/or evolving climate anomalies with possible negative impacts. Its preparation is based on one hand on climate observations, climate monitoring products and long range forecasts, and on the other hand, on the existing information on the socio-economic impacts of various global and regional climate patterns and extremes. Such patterns would be ENSO, MJO, NAO, Indian Ocean Dipole, etc. Therefore, a Climate Watch can serve as a mechanism to heighten awareness in the user community that a significant climate anomaly exists or might develop and that preparedness measures should be initiated.

Given the advances in climate monitoring and long range forecasting during the last two decades, it is now feasible for National Meteorological and Hydrological Services (NMHSs) to issue climate watches to help reduce socio-economic vulnerability by improving preparedness procedures for adverse climatic conditions.

In collaboration with WMO Commission for Basic Systems (CBS) and Commission for Climatology (CCl) experts, WMO developed in 2005 a technical document on Climate Watches referenced as WCDMP-No. 58, WMO/TD-No.1269, and available in electronic format at the WMO website: http://www.wmo.int/pages/prog/wcp/wcdmp/documents/GuidelinesonClimateWatches.pdf
The document describes the concept of Climate Watch, and guidelines for establishing, operating and evaluating Climate Watches (CWs).

Based on this development, Congress-XV discussed Climate System Monitoring and Climate Watches and various efforts undertaken through the WMO/WCDMP and CCl to provide information and assistance on how to organize and implement climate watches. It requested therefore WMO to support the organization of regional seminars/workshops on climate monitoring and Climate Watches and issued a resolution on future climate monitoring priorities which include: To enhance climate monitoring capabilities for the generation of higher quality and new types of products and services.

The WMO series of regional workshops on Climate Watches constitute a leverage in achieving this new type of products and services and aim at building capacity of the National Meteorological and Hydrological Services (NMHS) as well as of the regional climate institutions in the regions in need and hence enabling them to better contribute to the Implementation of the Global Framework for Climate Services (GFCS)

The Executive Council, EC-LX, Geneva, 18 to 27 June 2008, noted the urgent need for NMHSs and regional climate institutions to make use of best practices in delivery, provision and evaluation of Climate Watches, and in managing efficiently and seamlessly the interaction among the three involved parties: Regional institutions, NMHSs and end users. The Council urged all Members to assist in providing technical assistance to help developing and least developed countries to implement a Climate Watch System. The Council recognized the benefits of regional workshops to implement Climate Watches and noted the limited availability of funds for these activities. The Council therefore requested the Secretary-General to promote mobilization of extra-budgetary resources to carry this activity in all regions in need;

Congress-XVI requested the Secretary-General of the WMO to continue the support for this activity and promote resource mobilization to assist in the organization of more of such regional workshops, particularly for developing and least developed countries.

Objectives of the Workshop

The Workshop was sponsored by WMO and coordinated by the World Climate Data and Monitoring Division (DMA). It addressed the implementation of Climate Watches in the region with a focus on the sub region of eastern and southern Africa. The implementation of Climate Watch Systems in the region should be based on the existing infrastructure and expertise at national and regional level. The ultimate goal is to ensure that NMHSs and regional climate institutions make use of best practices in delivery, provision and evaluation of climate watches, and implement best practices in managing efficiently and seamlessly the interaction among the three involved parties: Regional institutions, NMHSs and end users.

A dedicated session on analyzing annual and decadal climate data was used to help countries provide their input to the WMO Climate System Monitoring, including annual statements on the global climate and the decadal global climate summary for 2001-2010.

The objectives of the workshop were to:

- Address the need for Climate Watches in the region,
- Review the status of climate monitoring and long range forecasting capabilities at regional and national level,
- Review and discuss Climate Watch showcases from the region and from abroad,
- Work on tailoring the WMO guidelines on Climate Watches to the region needs,
- Provide guidance and hands-on practical session for contributing to the WMO Climate System Monitoring CSM (annual and decadal scale)
- Recommend best practices for the region in issuing Climate Watches,
- Recommend best strategies towards users of Climate Watches,
- Develop an action plan to implement Climate Watches at national and regional level,
- Recommend a follow-up mechanism on the implementation of Climate Watches.

Linkage with WMO projects and activities

- Global Framework for Climate Services (GFCS)
- World Climate Research Program (WCRP)
- Climate extremes and Climate Change Indices (CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices - ETCCDI)
- Disaster Risk Reduction Program (DRR)

Roadmap for the implementation of a Climate Watch System (CWS) in the WMO region of Africa (RA I with focus on southern and eastern Africa)

Key issues, general and specific recommendations:

A: Format, content and dissemination of (national) climate advisories
- Simple language and if possible use local languages
- Key issues at the beginning
- Short and catching CWs
- Warning at the top and highlighted followed by a map and key message
- Update: drought 1 month, cold/warm spell shorter
- Conduct user surveys, visit impacted areas, share expertise, stakeholder workshop

B: Different aspects of (national) climate advisories including user involvement
- Partnership with users
- Gathering of socio economic data
- Collaboration of NHMSs and RCCs
- Improvement of data/data management
- Research and training on downscaling
- Expansion of networks
- Promotion of knowledge on the CWS
- Capacity development and bilateral collaboration

C: Basic infrastructure requirements and needs for (national) climate watch implementation including the role of the regional centers and capacity building
- Promote CWS
- Stick to WMO observation guidelines
- Train staff and users
- Improve access to products that are important for issuing Climate Watches
- Exchange information and knowledge among Members of RA I
- Continue Data Rescue
- Establishment of WMO RCCs in RAI

Other issues noted during the workshop:

- SADC-CSC: Refinement of forecasts is needed e.g. gap in predicting onsets of seasonal rainfall. Improvement of services necessary for practical application of seasonal forecasts.
- ICPAC products are easier to access than SARCOF due to lack of SARCOF capacity. Verification of SARCOF products to determine skill.
- Agreements and/or WMO Resolutions are needed, not only for sharing of data, but also for codes and products
- Quality control at regional ETCCDI workshops needs to be improved (spatially inconsistent results).
- Attribution of individual extreme events to climate change needs to be further assessed.

Action Plan (outcome of the workshop in April 2013)

Actions	Who	When
Proceedings	all	3 months
Make presentations available	WMO	1 month

List of participants	WMO	Immediately
Conduct need assessment	NMHSs	6 month
Briefing on tools and proposed CWSs (benefit of such a system)	NMHSs, RCCs	6 month
Look at past examples	NMHSs	1 year
CWS trial period	NMHSs, RCC	1 year
NHMSs should identify user groups	NHMSs	3 months
Sensitization and awareness campaigns	NHMSs, RCCs	Ongoing, long term
Assess density/historical data which should be available for CWS	RCCs	6 months
Establish WMO RCCs	WMO with RCCs	4 years
Set up a climate knowledge data base for extreme events	WMO with NMHSs	2 years
Establish national climate monitoring products as proposed by the Expert Team on National Climate Monitoring Products	WMO, NMHSs	2 years
Catalogue of products	NMHSs, RCCs	1 year
Training on CWs with users	NMHSs	2 years

Opening of the workshop

The workshop was opened by Rejoice Mabudafhasi (Water and Environmental Affairs deputy minister), Linda Mukuleni (CEOs SAWS and PR of South Africa), the General Manager of Operations, SAWS who introduced the deputy minister and the PR; and Professor Themba Dube (SAWS) as chair.

Linda Mukuleni introduced the Water and Environmental Affairs deputy minister shortly who welcomed the participants and highlighted right at the beginning that the implementation of a Climate Watch System will assist government to tackle the challenges of climate change in a regional and coordinated manner. In addition, she stated that a Climate Watch System for this sub-region will ensure that the necessary actions can be taken to mitigate the effects of significant climate anomalies that can cause extremes such as droughts, floods and heat waves.
"Weather and climate knows no boundaries, many examples can be mentioned where weather-related disasters in the region were addressed in a spirit of collaboration. We expect that with the knowledge of best practices in delivery, provision and evaluation of climate watches a huge difference can be made in how we work together as a region", Mabudafhasi said.
She commended the World Meteorological Organization and the South African Weather Service for organizing the workshop, adding that she hopes it will be the first step towards a continuous assessment of climate change related risks to provide decision-makers such as governments with the necessary information.
Given the advances in climate monitoring and long range forecasting during the last two decades, Mabudafhasi stressed that it is now feasible for National Meteorological and Hydrological Services to issue Climate Watches to help reduce socio-economic vulnerability by improving preparedness procedures for adverse climatic conditions.
She also noted that while indigenous communities have over a long period of time developed adaptation strategies to cope with the large spatial and temporal variability of the southern African climate, climate change with its associated extremes will cause these to become less efficient.
The South African Government, the deputy minister said, has put various mechanisms in place to mitigate climate change, but more importantly to adapt to the consequences thereof which is reflected in the various programs of different national and provincial departments, but most importantly in the National Development Plan. This plan acknowledges the probable consequences of climate change to the economy and the well-being of our citizens, and calls for, amongst others, an independent climate change centre, which will serve as a repository of all climate change related information. This will then serve as a source for the public and private sector to make informed decisions regarding the actions required to mitigate and adapt to climate change.

Karolin Eichler (WMO) on behalf of the WMO Secretary General Michel Jarraud expressed her gratitude to the government of South Africa for hosting this workshop and welcomed everyone.
She thanked especially the South African Weather Service for the organization of the workshop. In particular, she thanked Prof. Themba Dube and his team for the excellent organization of the event and the hard work during the last weeks and Mark Majodina from SAWS for initiating this workshop.
She also thanked all PRs of the participating WMO Members for their approval and the participants for their willingness to travel and collaborate at this short notice. Last but not least she thanked also the regional centers GPC, SADC-CSC and ICPAC for their attendance.
She referred to the last IPCC SREX report in which it was clearly stated that extremes have become already more frequent and that they will intensify during this century globally and also regionally in southern and eastern Africa. She recalled the drought in East Africa in 2011 when one of the driest years in history was recorded. In addition, she mentioned the challenging conditions in these two sub-regions that can be found as for example under El Niño conditions there is a higher probability of floods or wetter than normal conditions in eastern Africa and a higher probability of droughts in southern Africa.
She stated that the goal of this workshop is to start the implementation of a Climate Watch System in eastern and southern Africa which aims at providing advisories (Climate Watches) to inform users, particularly those involved in natural hazard preparedness, mitigation and response on ongoing, pending and/or expected climate anomalies and their negative impacts in order to make the transition from "crisis management" policies to "risk assessment/

risk management". This national task is based on existing infrastructure and should bring together GPCs, RCCs and neighboring NHMSs. Therefore National Meteorological and Hydrological Services (NMHSs) should be adequately equipped and prepared to continuously monitor and assess the state of the climate, evaluate available long range forecasts, and where conditions warrant provide to the users concise and understandable climate early warning information at weekly, 10-day, monthly, and seasonal time scale.

She recalled the importance of such a system in particular in support of the implementation of the recently approved Global Framework for Climate Services and noted the user oriented focus of this initiative for the development and provision of climate services. She informed the audience that the WMO series of regional workshops on Climate Watches constitute a leverage in achieving this new type of products and services and aim at building capacity of the National Meteorological and Hydrological Services (NMHS) as well as of the regional climate institutions in the regions in need, and hence enabling them to better contribute to the Implementation of the Global Framework for Climate Services (GFCS).

She referred to the decision made by the Executive Council, EC-LX, Geneva, 2008 that noted the urgent need for NMHSs and regional climate institutions to make use of best practices in delivery, provision and evaluation of Climate Watches, and in managing the interaction among the involved parties: Regional institutions, NMHSs and end users. In addition the Council urged all Members to assist in providing technical assistance to help developing and least developed countries to implement a Climate Watch System. In 2011, Congress-XVI requested the Secretary-General of the WMO to continue the support for this activity and promote resource mobilization to assist in the organization of more such regional workshops, particularly for developing and least developed countries.

She recalled that this workshop is the first of its kind in WMO RA I and the fourth regional workshop after South America, Asia and Europe which were held between 2008 and 2010, and that it will be focused mainly on international and regional projects and activities relevant to Climate Watch Systems and on the status and priority needs of monitoring and predicting climate anomalies and extremes on a national basis. In addition, working groups at the end of the workshop should help to adapt the general concept of a CWS to regional needs and to develop an implementation plan.

Again, she thanked the host for the excellent organization and everyone for their attendance and input.

Pre-Session on the Global Framework for Climate Services (GFCS)

Karolin Eichler (WMO) informed on the GFCS which is a global partnership of governments and organizations that produce and use climate information and services. It seeks to enable researchers and the producers and users of information to join forces to improve the quality and quantity of climate services worldwide, particularly in developing countries. In addition, the Framework will give priority to capacity building in these countries. Climate services are critical to prepare for climate change. Good management of climatic risks today is the foundation for managing the changed climatic risks of tomorrow. Adaptation, renewable energy, energy conservation and mitigation actions all depend on good climate information and climate services.
One of the main pillars of the GFCS is the User Interface Platform that provides ways for climate service users and providers to interact and improve the effectiveness of the Framework and its climate services. The Climate Services Information System as another component of GFCS should produce and distribute climate data and information according to the needs of users and to agreed standards.
Another pillar is Observation and Monitoring which aims at developing agreements and standards for generating necessary climate data. The last two are Research, Modelling and Prediction that harness science capabilities and results to meet the needs of climate services and Capacity Building to support the systematic development of the institutions, infrastructure and human resources needed for effective climate services. In addition examples of pilot projects were shown.

Brad Garanganga (SADC-CSC) informed the participants on the status of climate prediction and climate services provision in southern Africa and the Role of SADC-CSC in monitoring and predicting climate and providing climate services. He recalled the special influences in southern Africa which is indirect affected by tropical cyclones and directly affected by the monsoon season which takes place from November to March in the northwest and from April to October in the southeast. He also informed on the Seasonal Climate Prediction in southern Africa. In addition examples of seasonal predictions of rainfall including the model skills were shown. The limitations of the work at SADC-CSC were found to be:

- Inadequate observations,
- Inexact definition of climate,
- Incomplete understanding of systems,
- Cost of running models,
- Affordability of developing countries.

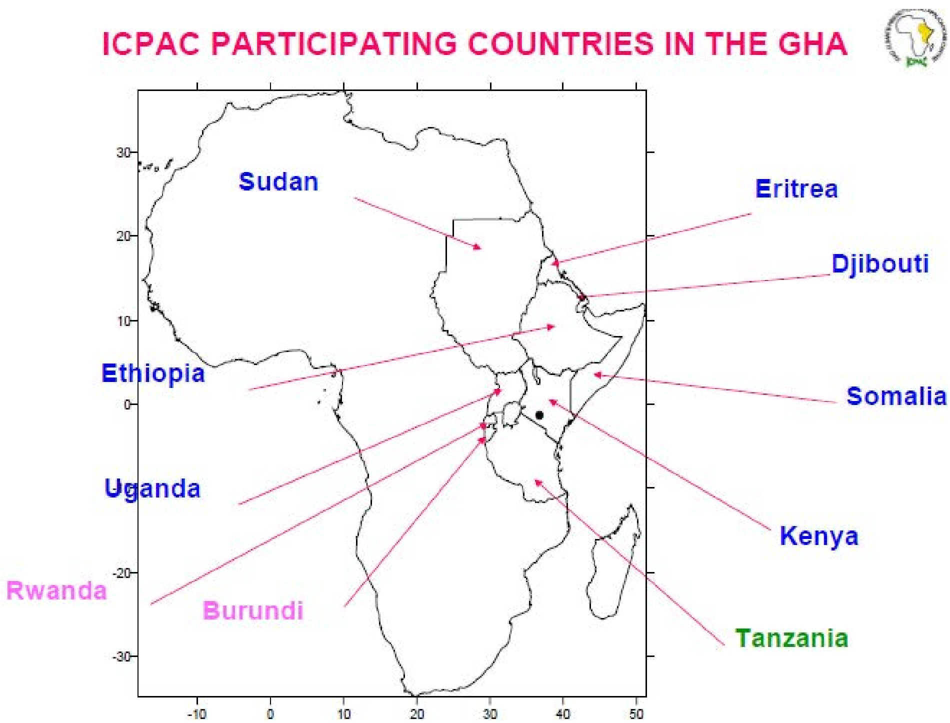
SADC-CSC is leading the SARCOF (Southern African Regional Climate Outlook Forum) process which is done for 3 months in advance and verified afterwards. Only rainfall predictions are made in this regard. SADC-CSC has 15 member countries and was established in 1989/1990. The main tasks are maintaining a climate data base, and monitoring and prediction of climate.

Joseph Mutemi (ICPAC) informed on the status of climate prediction and climate services provision in eastern Africa, the role of ICPAC in monitoring and predicting climate and providing climate services and climate variability and observed climate change in East Africa. ICPAC is serving as an RCC for 11 member countries and the core tasks are:

- Operational data service,
- Provision of climate data base and archiving services,
- Climate monitoring,
- Long-range forecasting
- Training in the use of RCC products

He mentioned the need to increase the station density in the region, in particular to include non-synoptic stations into the network. He also promoted the use of satellite data in data sparse areas. In addition he mentioned that enhancing RCOFs (Regional Climate Outlook Forums) routine climate watches go a long way in increasing climate

services for sustainable development and societal welfare, supported by weather and climate information. As RCC, ICPAC is now conducting three Greater Horn of Africa (GHA) Climate Outlook Forums (COFs) per year, namely MAM, JJA & OND. ICPAC has already issued 27 Climate Watches so far.
At the end he informed the audience that an increase in maximum and minimum temperature is visible in several station time series of eastern Africa.



Session I: Key lectures on rising awareness

Blair Trewin (BoM) gave an introduction to climate monitoring and stated that the most important issues when it comes to climate monitoring are:

- Availability and quality of underlying data,
- Timeliness of data,
- Long-term consistency of data,
- Generating large-scale analyses from various forms of source data,
- Capacity to operate analysis systems,
- How to visualise data with a wide range of climatological values.

He also explained how to calculate an anomaly (calculate station monthly mean temperature from daily data, calculate long-term normal temperature for station, calculate difference between monthly mean and normal temperature). He mentioned the difficulties in referring to different base periods and the importance of homogenous data. He also gave the advice that key drivers such as ENSO should be monitored.

Andries Kruger (SAWS) informed on climate variability and observed change in South Africa. The identified challenges mentioned in this regard were:

- Data quality,
- Available parameters rainfall and temperature are most widely measured. Other parameters are increasing in importance (e.g. wind for wind energy potential and proper design of infrastructure) but have limited long-term measurements available.
- Metadata (e.g. move of stations, instrument types, changes in exposure, roughness etc.)
- Lengths of records,
- Spatial density,
- Optimal assessment of trends (maximum period with sufficient density of continuous measurements)

He presented the WMO climate indices that are applicable for South Africa and showed global and regional trends:

- Annual number of warm days and nights has increased
- Annual number of cool days and nights has decreased
- Southern Africa – stronger trends for 1951-2010 vs. 1901-2010
- South Africa: 1961 – 2010 (28 stations) (Kruger & Sekele, 2012):
    - Spatially variable results, but general increase of warm days and nights and decreases cold days and nights;
    - Northern and Southern Cape: greatest increases of warm days: 2 – 4 days/decade
- South Africa: mean trend +0.174°C/decade (1961–2010) is similar to increasing global trend + 0.177°C/decade

Analyses of longer time series confirm the likelihood that warming has accelerated since the mid-1960's.
There is a tendency toward wetter conditions: intensity, frequency, and duration of extreme precipitation are increasing on average. The results are spatially highly variable. In Southern Africa with regard to 1901 – 2010, wetter conditions to the north and south, and drier conditions in central parts (central souther Africa, parts of Mozambique), were recorded.
Regional results of extreme indices are limited to South Africa. Significantly positive trends in amount of annual precipitation from extreme daily events were observed in the Southern Free State and most of Eastern Cape with regard to 1910 – 2004.

Suggestions made during the presentation were:

- Identification of regional long-term key stations, especially those still operational;
- Metadata from regional stations

- Proper data quality control
- Regional contribution to global analyses
- On-going data rescue
- Sector-specific indices (e.g. health)
- Strategic expansion of observation network

Blair Trewin (BoM) informed on climate extremes, current status of knowledge and operational needs and challenges. He presented the terminology and outcomes of the IPCC SREX report and the WMO bodies that are relevant to climate extremes like the Expert Team on Climate Change Detection and Indices (ETCCDI) and the Task Team on Definition of Extreme Weather and Climate Events (TT – DEWCE). He gave a short overview of the work of the two teams which are:

ETCCDI:

- Development of consistent indices for monitoring climate change and variability
- Organising and sponsoring regional climate workshops for generation of indices
- Sponsoring and disseminating software (e.g. RHtests for homogenisation, RClimDex for index calculation) and other technical information

Task Team on Definition of Extreme Weather and Climate Events (TT-DEWCE):

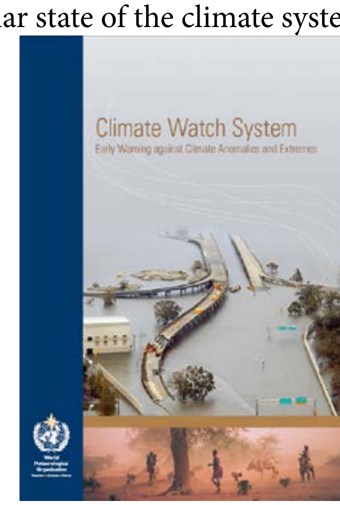
- Task Team still in early stages of operation
- Major goal is to develop consistent definitions of regional (as opposed to site-specific) extreme events
- Aiming to support global communication of significant information (e.g. through portals giving easy access to national/regional information)

At the end some challenges in near real-time extremes monitoring were mentioned:

- Data availability for global/regional analyses
- Availability and quality control of data in a timely manner
- Consistency of regional analyses
- Knowledge of historical extremes
- Homogeneity of recent data with historical extremes
- NMHS capacity to monitor and interpret extreme events

Karolin Eichler (WMO) gave a short overview of the WMO Climate Watch System, its purpose and requirements. It was said that setting up an efficient extreme weather and climate warning system has long been a focus of WMO. Its main governing entity should be the National Meteorological and Hydrological Services.
She referred to the components and requirements of such a system and showed examples of already issued Climate Watches. At the end a summary was given that highlighted that CWs are:

- Issued to heighten awareness in the user community concerning a particular state of the climate system;
- Disseminated to serve as a mechanism for initiating preparedness activities by users and/or a series of events that affect user decision making;
- Based on real-time monitoring (current status) of conditions and on climate outlooks;
- Issued by individual NMHSs, perhaps in coordination with other NMHSs or regional Climate Centers in the region or beyond;
- Developed as a result of continuous and iterative collaboration with users



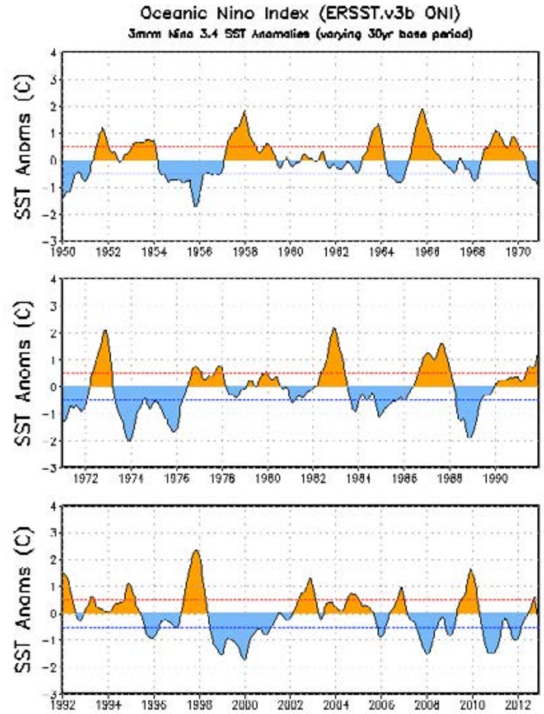
Michelle L'Heureux (NOAA) informed on Climate Watches at the global level. The objectives are to succinctly describe the onset and status of ENSO in order to increase understanding among federal and state agencies, academia, the private sector, and general public and to heighten awareness in the user community that a significant climate anomaly exists or might develop and that preparedness measures should be initiated.
The NOAA ENSO Alert System became operational in February 2009. It was developed at the Climate Prediction Center and the system is based on CPC/IRI's operational ENSO definition, assessment, and prediction activities as a follow-up to a decision by the WMO Executive Council that urged all members to develop and implement Climate Watches. The following types of alerts exist:

- An El Niño or La Niña Watch:
Issued when the environment in the equatorial Pacific basin is favourable for the development of El Niño or La Niña conditions within the next 6 months

- An El Niño or La Niña Advisory:
Issued when El Niño or La Niña conditions in the equatorial Pacific basin are observed and expected to continue

- Final El Niño or La Niña Advisory:
Issued after El Niño or La Niña conditions have ended

- NA:
The ENSO Alert System will not be active when El Niño or La Niña conditions are not observed or expected to develop in the equatorial Pacific basin

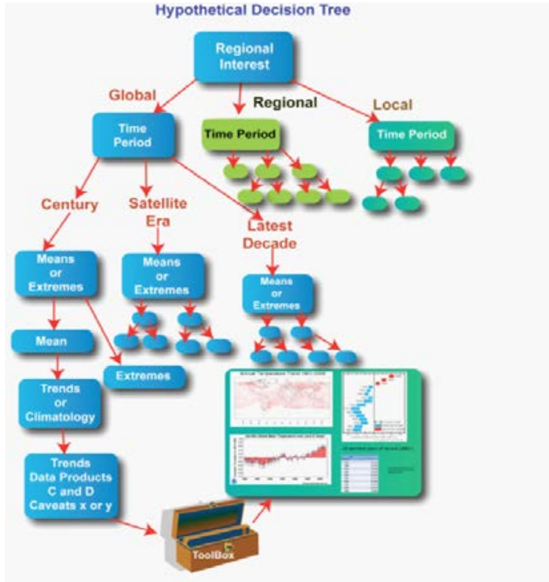


The NOAA operational definition for ENSO is based on the Oceanic Niño Index ("ONI") which is based on SST departures from average in the Niño 3.4 region, and is a principal measure for monitoring, assessing, and predicting ENSO. The ONI is defined as the 3-month average SST departures in this region. Departures are based on a set of improved homogeneous historical SST analyses. Therefore El Niño is characterized by a positive ONI greater than or equal to +0.5°C and La Niña is characterized by a negative ONI less than or equal to -0.5°C.
Another global-scale product that eventually could be tied into a climate watch system is the Experimental Global Drought Information System (GDIS): http://www.clivar.org/organization/extremes/activities/GDIS-workshop

As a last presentation in this session Blair Trewin (BoM) reported on the International Surface Temperatures Initiative (ISTI). He informed the participants that there are already several independent global estimates of land surface air temperatures. Global surface temperature records are the key line of evidence but the link from station data to global averages is indirect (statistical problem – reconstruction depends on methodology used), the data holdings are dispersed with poor provenance and only a few user tools are existing. The main concerns are:

- Evolving station networks;
- Changes in measurement technique/station location/recording practice (often undocumented);
- Urban "heat island" effects; etc.

ISTI got started through a submission by UK Met Office to World Meteorological Organization Commission for Climatology in 2010. It called for creating new suite of products to meet 21st century demands and expectations. A first instigation workshop was hold in September 2010 in Exeter, UK and was attended by 80 international experts including climate scientists, metrologists, statisticians and software engineers. He reported on the progress to date which includes the setting up of a steering committee including the terms of reference. The initiative is sponsored by World Meteorological Organization and the International Environmetrics Society (seeking International Bureau of weights and measures). The working groups on databank and benchmarking are active and a first version of databank made public and data sources coming in. The Implementation Plan published and the progress is documented on initiative website at www.surfacetemperatures.org



Session II: International and regional projects and activities relevant to climate watch systems

Asmerom Beraki (SAWS) reported on the available climate monitoring and forecasting products at the GPC-Pretoria. GPC Pretoria was recognized as a GPC in 2009 with the objectives to improve the access and uptake of LRF products for use by RCCs, RCOFs and NMHSs to aid production of regional/national climate services and to help to reduce the socio-economic losses associated with seasonal variability, and protect life and property. He presented the products of the GPC which are global precipitation and temperature forecasts for 3 seasons (up to 5 months ahead). He identified challenges and limitations which are:

- No ENSO no skill (for Southern Africa region)
- Mid-latitude jet stream southward migration is not detected in the model;
- Lack of lower stratospheric temperature cooling
- IOD predictability is still limited to the austral spring period (October) to the start of summer (December)

Peter Bissolli (DWD) informed the participants of a show case on CWS and the experience of the European Regional Climate Centre. He mentioned that RCCs are Centres of Excellence that assist WMO Members in a given region to deliver better climate services and products including regional long-range forecasts, and to strengthen their capacity to meet national climate information needs. He informed the participants that RCCs provide regional-scale tailored climate services on Climate Data, Climate Monitoring and Climate Outlook and projections. In Europe the structure is the following:

- RCC on Climate Data: various data sets for Europe, both station data and gridded data (ECA/D, MILLENNIUM, ENSEMBLES, BALTEX, SHARK) and various sub-regional data sets services like archiving functions and data management tools
- RCC on Climate Monitoring: Maps, reference climatologies, anomalies, indices, trends, statistics reports, significant weather event data base, climate watch (advisories on possible future events)
- RCC on Long-Range Forecasting (seasonal forecasts): Seasonal forecast bulletins, maps and graphs on model performance, seasonal outlooks, consensus statements, model verification.

In addition he presented a Climate Watch example which has been issued during late summer 2012 in Europe. The advisory was appreciated by the NMHSs and by WMO and it was also taken for formulation of a more detailed national climate watch. In general it is recommended to use not only forecasts but also monitoring products including the current circulation patterns, to understand/attribute extreme anomalies.

Session-III: Country presentations on the status and priority needs of monitoring and predicting climate anomalies and extremes

Botswana

The Meteorological Service of Botswana is maintaining 17 synoptic stations (no automatic weather stations) and more than 200 rainfall stations. Only 7 stations have continuous data from 1960 to present. The other stations are relatively new.
The database (Climsoft) is in the process of being upgraded. Many data gaps exist and sometimes the data quality and coverage is not good enough. The main needs are to have more and better-educated personnel and to upgrade the data management system. A seasonal forecast (done in conjunction with SARCOF) is done for a 3 month timescale and updated monthly with the help of a statistical model and dynamic models from global centers.

Burundi

Burundi has an area of 27,830 square km and is located south of the Equator between latitudes 2.3°S-4.5°S and longitudes 29°E-31°E. The country's economy is essentially dependant on rain-fed agriculture. About 90% of the population live in rural areas and are engaged in agricultural activities. Burundi experiences two rainy seasons. The first lasts from mid-September to December. The second starts from mid-February to May. The two seasons are separated by January, which is generally a small dry season. Burundi Meteorological Service issues 10-day and monthly bulletins as climate monitoring tools and maintains 17 synoptic and climatological stations, 24 temperature and rain gauge stations and 125 rain gauge stations.
The 17 synoptic stations send the data on a daily basis to the headquarters. The remaining stations send the data through post after each month. The data is then quality controlled and sent to the computer section for data entry, where the data is processed and archived in order to produce 10-day and monthly summaries or bulletins. IGEBU (INSTITUT GEOGRAPHIQUE DU BURUNDI) through the Hydrometeorological Department is producing 10-day and monthly bulletins and has recently acquired a cluster through the East African community to run the WRF regional model. They also use EPSgram from ECMWF for Burundi to produce 48 hours forecasts in addition to the use of CPC/NCEP products and SWFDP products to issue warnings. Burundi is participating in PRECOF and COF for seasonal forecast consensus at ICPAC.
In support of an early warning system (EWS) the head of the climatological section is participating in food security meetings as part of the data input in advance of the season. After every COF, potential user such as media, agriculture, water resource, energy, health and disaster risk reduction are invited to release the forecast and interact on how they are going to use it. A limitation mentioned was that some of the observers aren't well trained and that therefore the data is sometimes less reliable. In addition Burundi has no school of meteorology in the country hence there is a lack of qualified personnel. Due to a lack of sufficient meteorologists there is not enough capacity to monitor and interpret extreme events and climate analysis. Also the cost of running models (equipments and human capabilities) was mentioned.

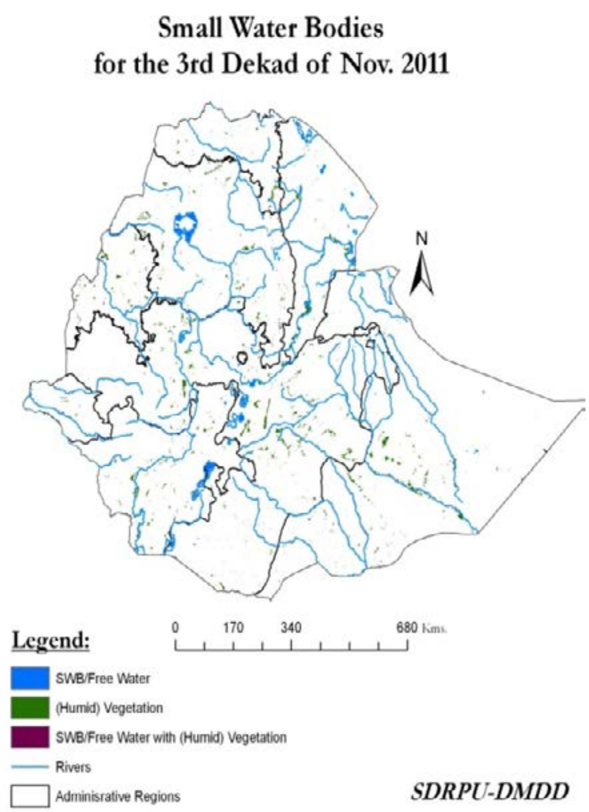
Ethiopia

The first meteorological stations were established in Ethiopia in the 19th century by missionaries and explores as for example in 1890 and 1896 the weather stations in Adamitulu and Gambella respectively by the Italians. During the five years (1936-1941) of the Italian invasion 192 stations were established in Ethiopia, and since 1951 for the purpose of flight operations, 495 aeronautical and climate stations were established. After the establishment of NMSA (1980), the total number of stations increased substantially to 1200; but later the number of stations dropped to 548. The total number of stations has now rebounded and is more than 1200. Among these stations, manned surface observing stations, automatic observing stations, upper air stations, radiosonde and pilot balloons, satellite data receiving stations, stations at the airport – mainly for air navigation - and meteorological Radars can be found.

The branch offices manage the stations found in their area of responsibility. The data is entered to a computer at the branch office and sent to the headquarter by email, CD's or diskettes. All data from branch offices sent to HQ are managed, organized, processed and stored on computer, archived in hard copy and delivered to users.
Climate bulletins are issued at monthly, seasonal and annual time scales. The monthly climate bulletins contain synoptic situations, tropical oceanic and atmospheric highlights, weather (extreme temperature along with the date), rainfall, reports of heavy rain falls along with the date, stations with more than or equal to 100 mm of rainfall during the month, new heaviest monthly rainfall recorded during the month, and rainfall maps. Seasonal Climatology Bulletins include the same information as monthly bulletins but refer to specific seasons and the annual Climatology Bulletin refers to a specific year.
The National Meteorological Services Agency of Ethiopia issues a seasonal climate outlook three times a year. The forecast is given at the beginning of Kirmet, Bega and Belg seasons. Kirmet spans from June to September, Bega spans from October to January and Belg spans from February to May.

Methods of selecting analogue years

- Plot sea surface temperature anomalies (SSTA's) and Multivariate ENSO Index (MEI) of the 4 Niño regions (NIÑO1+2, NIÑO3, NIÑO3.4 and NIÑO4) from 1971 to current and observe the graphical trend
- Perform partial correlation between the current year and all other years to get 20 similar years
- Examine the SST forecast for the upcoming season. It could be El-Niño, La Niña or Neutral
- Use this information to disregard years which have got dissimilar SSTA pattern with the forecast given for the current year.
- Do correlation and look at the trend thoroughly and get 10 most similar years with the current year
- Compare pre-seasonal monthly rainfall and temperature distribution of the selected years with the current year. Also consider extreme cases (dry spells and heavy rain etc) of pre-seasonal months, SST of Indian and Atlantic Oceans, and weather systems. Using these information one can select 5 or 3 analogue years.
- In short, NMSA compares SSTA's and MEI between the current year and previous years (starting from 1971) to determine an initial series of analogue years. Regional situations such as sea surface temperature of neighbouring oceans, pre-seasonal monthly rainfall patterns, weather systems and the like are then used to refine the first selection.



Methods of prediction

- After selecting the analogue years, we classify the stations into homogenous rainfall zones. NMSA has adopted the method of principal component analysis to regionalize the country into homogenous rainfall zones.
- Get the seasonal rainfall amount for each station.
- Get the percentiles (<33% correspond to below normal, 33%- 66%-normal and >66% -above normal)
- Count the number of stations with Above Normal (AN), Normal (N) and Below Normal (BN) and calculate the percentage of stations with AN, BN and N out of the total for each homogenous rainfall zone separately
- Do step four for all analogue years, in particular for the best three analogue years.
- Calculate the average for the three selected analogue years. That will be the forecast.

The rainfall in the region is highly variable, especially during the short rainy season in Ethiopia. Predictability of rainfall in the short rainy season is low compared to that in the long rainy season.

Problems:

- Not all data are computerized
- Failure of Data Base Systems at times
- Lack of trained personnel, fast advancement of technology
- Network lines between head and branch offices not yet completed
- No well organized and documented metadata of stations and instruments

Data gaps and length

- Most of the stations start recording in the 1970's and have lot's of gaps
- Data gaps occured due to many reasons (war outbreak, absence of observers and leaving the organization without prior notice, instruments breakdown and slow maintenance services)
- Acquiring modern instruments needs a high budget and using them requires trained personnel.
- Data demand and supply do not agree

User activities in support of climate risk management and early warning systems include data bases and preparedness and mitigation procedures. Some users have installed AWS (e.g. WFP). They get in return the AWS data and daily data on six parameters from 40 stations equipped with radio. They use the data for running Livelihood, Early Assessment and Protection (LEAP) software. NMSA is working with the Ethiopian Environmental Protection Agency in the areas of climate adaptation and mitigation and collaborating with the Disaster Risk Management and Food Security Sector (DRMFSS).

LEAP (Livelihood, Early Assessment and Protection) is the Government of Ethiopia (GOE) owned food security early warning tool embedded in the national risk management framework and linked to the US$ 160 million contingent fund. LEAP converts satellite and ground-based agrometeorological data into crop or rangeland production estimates and ultimately into livelihood protection requirements. It also quantifies the financial resources needed to scale up PSNP in case of a major drought.

Kenya

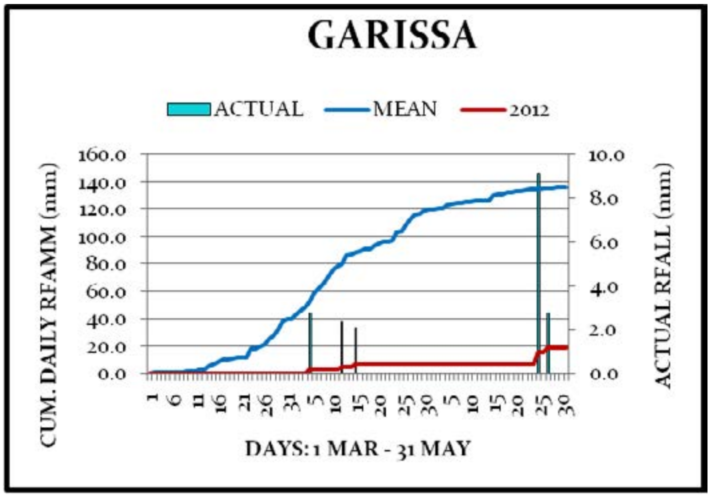
In Kenya, agriculture is the mainstay of the economy. Pastoralism and agro-pastoralism form the major livelihood activities of the country's population in the arid and semi-arid lands (ASALs). Hydro-energy generation for both industrial and domestic activities depends heavily on sufficient water in the hydro dams. All these activities and many others are principally rain dependent. Seasonal rainfall performance is, therefore, of great concern to all stakeholders who depend on rainfall for their social- economic activities.

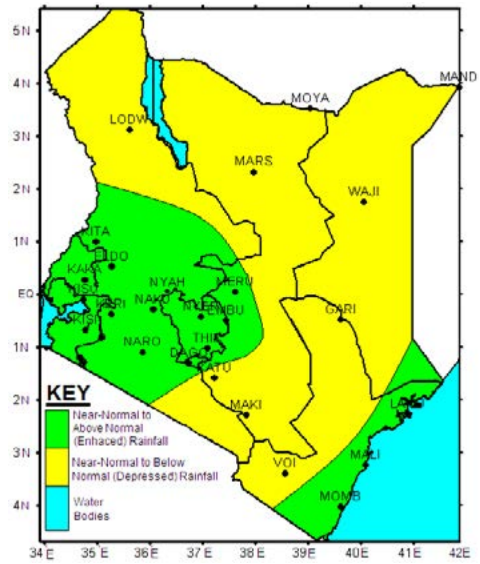
The department's current observational network consists of 39 manned 24-hour synoptic stations, 14 agro-meteorological stations, 72 Automatic Weather Stations (AWSs), 3 Airport Weather Observation Systems (AWOSs) at Nairobi, Wilson & Mombasa, 17 Hydrometeorological AWSs for flood forecasting and about 1000 rainfall stations most of which are operated by voluntary observers. In addition 1 Upper Air Station exists at Dagoretti and two other stations for Garissa and Lodwar are awaiting installation. There are also 3 satellite ground receiving stations (2 for MSG and 1 for NOAA satellite data). To monitor pollution 1 GAW station on Mt. Kenya and 2 stations in Nairobi have been installed. To support tsunami early warning 4 tidal gauge stations were installed at the coast, at Lamu, Mailindi, Kilifi and Shimoni for multihazard detection, ocean waves, sea level rise, salinity, sea surface temperature and water quality.
GSM technology is being used for data transmission from most of the stations to the HQs. The HF-SSB and telephones are used as back-ups to collect data from the synoptic weather observation stations. KMD has a regional responsibility and hosts the WMO Regional Telecommunications Hub (RTH) for receiving and disseminating of weather data from neighbouring countries to the rest of the world. The Climsoft Database Management System is used for data key entry, basic quality checks that are performed automatically, encoding, archival and products. Currently efforts have been made in data rescue. Paper forms were converted to digital images by photograph and the data was entered into Climsoft. About 10 % of the data was rescued. In addition data and products from all the observational systems (WIGOS project) were integrated. The data policy on exchange of climate data is now in line with the international standards and best practices of the World Meteorological Organization (WMO). Also, a climate diagnostic laboratory will be developed. A cluster system for generating climate scenarios has been acquired.

The following climate monitoring products are available:
- Seasonal climate outlook
- Anomalies (monthly, seasonal and annual)
- Extreme temperatures and rainfall
- Monthly highest and lowest temperature (monthly bulletin)
- Rainfall and temperature trends (simple trends based on daily and values-regional)
- Dry-spell analysis (done by agro met section as part of drought monitoring for agriculture, 10-day, monthly, seasonal bulletin)
- Onsets and cessation of rainfalls (issued in seasonal bulletins)
- Severe weather predictions and advisory

For the long-range forecasting an empirical statistical regression of sea surface temperatures (SSTs), SST gradients and the expected evolution of global SST patterns as well as upper air circulations patterns (ENSO events, IOD etc, tropical cyclones) is used in addition to dynamical models from global producing centers, drivers of weather/climate in Kenya and ICPAC products. To determine the onsets and cessations of the rainy season, the analogue year (i.e. scan through past records to isolate a year) is determined with almost similar climate drivers to the current year. An analogue year is defined as that year in the recent or distant past that exhibits the most similar characteristics to the current year. The analogue year helps us to infer the characteristics of the season under investigation (i.e. onset and cessation dates as well as the likely rainfall distribution).

The activities in support of climate risk management and early warning systems are:
- To issue 24 hr, 5 days, monthly and seasonal forecasts containing advisory for any expected extreme event
- Established community radio broadcasting RANET
- Established regional weather offices and downscale national outlook to county level and engage users directly
- Established flood risk warning system along known rivers
- Severe Weather Demonstration Projcet (SWFDP) products issued by RSMC NAIROBI
- Frequent seminars and workshops with stake holders including journalists, Red Cross, national disaster units among others
- Work with farmers groups for dissemination and feedback





The major needs or issues at the moment are the ongoing data rescue, capacity building in climate data analysis, the observational network expansions, the large gaps in available data, the short historical data and the inconsistent or absent metadata.

Lesotho

Lesotho has 92 operational stations (52 rainfall, 27 climate, and 13 "Major", of which one is synoptic and reporting along with one none operational AWS). The recorded climate data is mainly sent by post on a monthly basis. For the major stations the data is transmitted via telephone. After the data has been sent it is registered in the register book and initially quality controlled. Afterwards it is archived and digitised. Since 2006 CLIMSOFT is used instead of CLICOM as a climate data base management system. The earliest records are rainfall data from 1896; temperature series start in the late 1960s. Climate monitoring is done on a daily (daily climate monitoring), weekly (weekly weather briefs) and monthly basis (monthly bulletins). Lesotho is participating in the SARCOF long range forecast. Therefore a climate prediction tool (CPT) and Systat are used. The major needs are more human capacity, an upgrade in infrastructure including more AWSs and an increased observation distribution. In addition old data is at risk of being lost.

Malawi

Mission: To provide reliable, responsive and high quality weather and climate services to meet national, regional and international obligations through timely dissemination of accurate and up to date data and information for socioeconomic development.
Mandate: To monitor, predict and provide information on weather, climate and climate change that would contribute towards the socio-economic development of the country.
Motto: Be wise, be weather wise

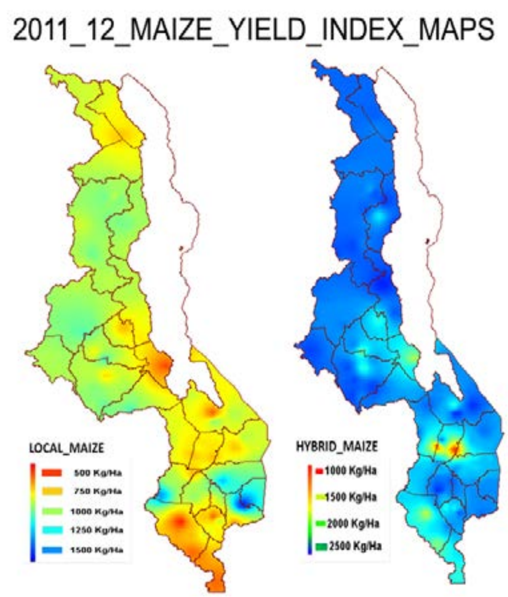
The core values of the meteorological service in Malawi are the protection of life and property, the access to weather and climate information, networking, commitment, the investment in technology, innovation and team work.

Functions
- Provision of weather and climate observation and communication services;
- Provision of weather and climate forecasting services and climate projections for the development of climate change adaptation and mitigation programmes;
- Provision of technical coordination and implementation of climate change issues;
- Provision of weather and climate data and information for various socio-economic sectors;

- Provision of climate change and meteorological education and outreach services;
- Provision of climate change and meteorological research services
- Provision of financial, administrative and support services.

The present department started as a small unit in the Department of Civil Aviation and became a fully fledged department in 1983. Now it has about 300 staff members across the country. Among others, it is supporting the safety and efficiency of national shipping and maritime affairs and civil aviation. In addition, it supports the climate change adaptation and new innovations that require new technology.

The seasonal rainfall monitoring process consists of a seasonal rainfall forecast, the monitoring of the timeliness of the start of the rains, the monitoring of the rainfall distribution, dry spells, floods and their impact on agriculture and food security. Seasonal rainfall monitoring is done through a combination of ground reports received from a network of weather stations and rain gauges scattered over the country, remote sensing imagery, and rainfall/crop water balance modelled products. DCCMS monitors the crop growing season using observations from a network of weather stations and rain gauges scattered over the country, satellite information (NOAA rainfall estimates (RFE) and NDVI with 8km resolution, or high resolution Spotvgt – 1.1km), and a FAO Crop Specific Water Balance model which relies on information on weather, climate, crop and soil water holding capacities and fortnightly crop reports. In addition a 10-day rainfall and agrometeorological bulletin, weather forecasts and updates (short (up to 3 days), medium (5 – 10 days), seasonal (up to 6 months)) are issued.



Meteorological infrastructure
- Data observational systems and network;
- Data telecommunication systems and network;
- Data procession, analysis and forecasting systems;
- Product and information dissemination systems;
- Human resource capital

Current observational network
- Synoptic stations: 22 manned 24-hr surface synoptic stations, 15 agro-meteorological stations
- Automatic Weather Observing Systems: 33 automatic weather stations (AWSs), Satellite Distribution and Information System (SADIS) at Kilimanjaro International Airport (KIA)
- Rainfall Stations: used to have 700 rainfall stations, most of which are operated by voluntary observers and less than 100 now active every year.
- Rainfall Logging System: 34 operational with issues
- TV weather studio
- EUMETSAT Satellite Data Receiving Station
- Automatic message switching system (AMSS) for data telecommunication and exchange
- Upper air observation station: not functional
- Weather radar: not functional

Products for early warning, disaster preparedness and mitigation
- Short-range weather forecasts (24-hours-3days);
- Medium-range weather forecasts (7-days, 10-days);
- Long-range forecasts (30-days or monthly) and (90-days or seasonal weather outlook)
- Forecasting capability: Tailor-made forecasts as a decision support tool for planning and preparedness in weather and climate sensitive sectors;
- Wide range of aviation forecasts, pilot briefing, air traffic controllers, terminal forecasts, enroute and land

ing forecasts)
- Climatology
- Data Management and related services
- Climate Change and Research (new unit): carry out research and development that would improve quality of weather and climate change information

<u>Challenges</u>

- Policy and legislative Matters

There is need to have national legal instruments to define the mission and mandate of the department which will ensure that the department's responsibilities are well-defined nationally and its contribution to society is appropriately recognized to ensure adequate resources. DCCMS lacks an Act of Parliament establishing its existence. The mission statement should be affirmed in a "Meteorological Act" and Law or other official governmental instrument; policy is under development and strategic plan have to be finalised

- Operational matters

DCCMS receives a low budgetary allocation and has therefore problems in upgrading its equipment, plant and instruments required for improved information, products and services. Two planned projects are modernization of meteorological services, and climate change and meteorological capacity development, but these two projects cannot be realized with the current government funding; there is need for a financier.

- Human resource matters

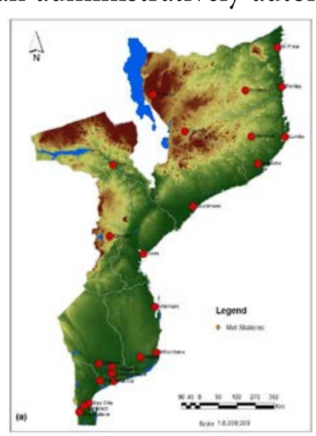
10 graduates need further training, 13 diploma holders need further training and refresher courses are needed in general

- Service delivery matters

- Inadequate technological and marketing capacity to meet the needs of an increasing sophisticated public and private sector clientele
- Lack of proper guidelines for meteorological, hydrological and climate-related services
- Need for continuous public education and awareness

Mozambique

In 1883 the first meteorological observations were recorded in Mozambique. In 1908 Mozambique Meteorological Service (SMM) was established and in 1989 the SMM became the National Institute of Meteorology (INAM). It is subordinated to the Ministry of Transport and Communications. INAM is an administratively autonomous but not financially autonomous institution.



The main activities are
- Weather and climate observations;
- Public weather forecast;
- Marine weather forecast;
- Aviation weather forecast;
- Climate seasonal forecast and;
- Research (in process of its establishment and focused on the application of meteorology);

In 2013 the network of INAM consists of 29 synoptic stations, 14 agroclimatological stations, and 43 rain gauge stations (total: 86 stations). The data are still centrally (headquarter) digitized, validated and integrated into the data base management system CLICOM. A decentralization process for data digitization is ongoing at provincial

level to maximize the data flow. The data quality is still a concern due to many gaps and digitization errors. To minimize these gaps a 30-year (1979-2009) gridded data series was generated with a spatial resolution of 40 km and this data can be used for research scientific purposes.
A total of 13 CLIMATs are generated and sent monthly and integrated into GTS system (only Beira and Quelimane are directly sent to GTS via MESSIR). A rainy season monitoring bulletin is produced. The monthly meteorological and 10 days agro-meteorological bulletins are published via INAM website. Regional and global monitoring products are used for climatic seasonal forecasts (long range), 2 to 5 days forecasts (medium range) and daily forecasts (short range).
Mozambique participates in the Southern African Climate Outlook Forum (SARCOF) since 1999. The seasonal forecast in the country is made available in early September after the SARCOF. The forecast is made by implementing the SARCOF approach which is purely statistical analysis based on the historical relationship between precipitation and preceding global sea surface temperatures (SSTs). Since the 2010-2011 rainy season INAM started implementing a second forecast approach in test mode; a canonical correlation analysis, (CCA) between Global Climate Models (GCM) outputs and precipitation.

User Activity in support of climate risk management and early warning systems including data base and, preparedness:

- Drought and Flooding:

In the pre-rain season the contingency plan is elaborated to respond any contingency event due to aforementioned phenomena, in collaboration with the Water Division, Ministry of Agriculture, Minister of Environmental Affairs, Minister of Health, Red Cross, Meteorological Services, Army and other institutions, and NGOs (WFP, FEWS-NET), under the coordination of Disaster Management Division.

- Heat waves, heavy precipitation (& thunderstorm):

The meteorological service (INAM) produces and issues to the different users warnings about the high chance of occurrence of heat waves, heavy precipitation or thunderstorms and advice to consider all the recommended procedures to avoid any risk.

- Dry spells:

In the rainy seasons that are likely to start late, after the first rains, usually farmers are advised to plant slightly later than usual, using a recommended seed.
This warning is made by a specific department of the Ministry of Agriculture with the support of the meteorological service and then broadcasted via media.

Challenges forthcoming actions

- Improvement of the station network so that an ideal network is set up;
- Continue with data rescue, digitization and quality control;
- Continue to implement the data digitization decentralization process at provincial level to maximize the data flow and reduce the load to the headquarter personal;
- Lack of skilled human resources for data analysis and climate monitoring;
- Seek opportunities for short training courses or on job-training opportunities in order to skill human resources to respond and improve the climate seasonal forecasts by implementing other techniques and global models data output.
- Motivate the research activity in order to improve the quality of different products and also as a way for skill and expertise exchange.

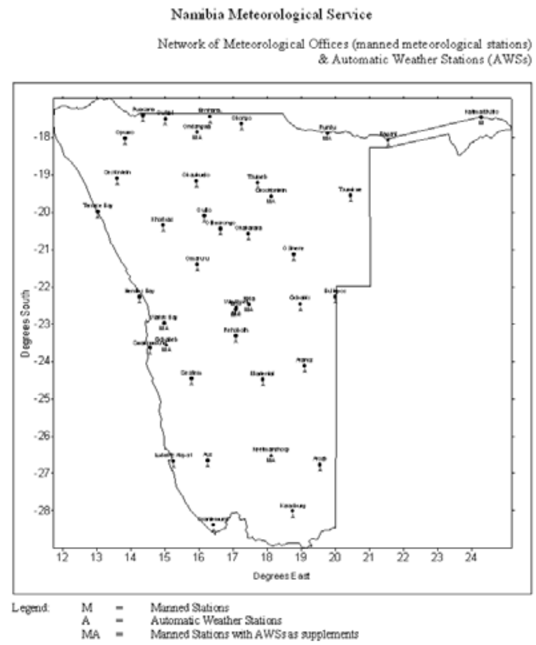
Namibia

Climate data is collected from about 100 stations; 8 of these stations are synoptic stations, the rest are 'rainfall-on-

ly' stations. Climate data is managed through Oracle based Clidata data base management system (DBMS), with Clicom in the background and used mainly for data entry, both at head office and in the regions.
GCOS climate monitoring principles are applied to the extent possible within limitations imposed by staffing and other constraints. In particular, data management systems that facilitate access, use and interpretation of data products are included as essential elements of climate monitoring systems. Regular Climate Monitoring products and reports are 10-day rainfall bulletins (January to April), monthly rainfall bulletins (October to April) and winter temperature bulletins (May to September). Climate data and information is disseminated to individuals and sectoral users that include:

- Print and electronic media;
- Agricultural users;
- Water resources;
- Environment, Education and research;
- Construction industry
- Health authorities;
- Legal and insurance users and
- Directorate of disaster and risk management.

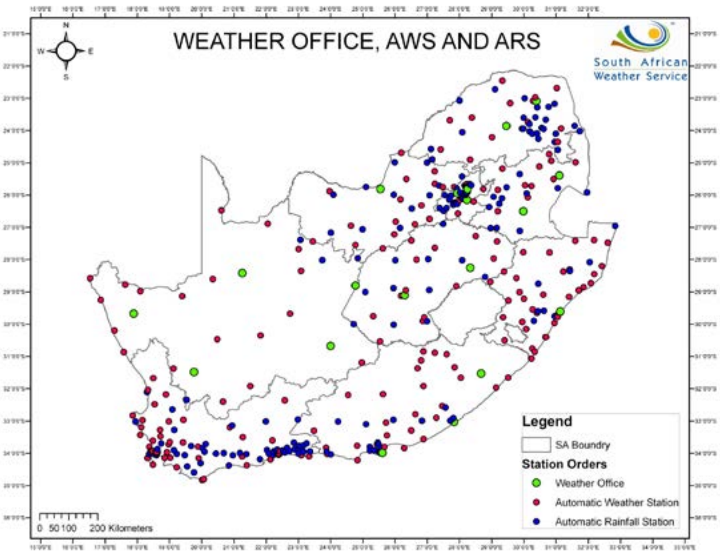
Analysis of requests for climate data and information documented recently shows that climate data and information is used in many socio-economic sectors for planning purposes, and enterprise monitoring purposes.



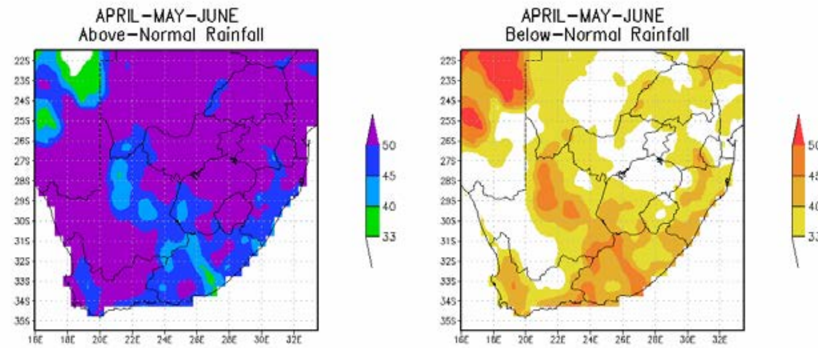
South Africa

SAWS is maintaining 156 AWS (unmanned), 35 AWS (manned), 25 weather offices, 165 automatic rainfall stations, 23 climate stations, 23 Sea Surface Temperature stations, 1257 rainfall and 9 Upper Air stations. All data is entered into a DBMS and quality controlled for the first time in the regional office before the final quality control is done in the headquarters.
Data is either used for commercial purposes (including funded research, but a service fee is charged for the extraction and dissemination of large amounts of data; disclosure statement to be completed) or public good purposes (near real-time data (daily maximum & minimum temperature and rainfall); and also for educational purposes (learners and students) upon completion of a disclosure statement (especially students at tertiary institutions)).
Dissemination is possible in many formats; value-added products, e.g. 10-day and monthly rainfall maps are available on the SAWS website, and subscriptions for regular products/publications are possible. Monthly and annual averages of minimum, maximum, dry-bulb and wet-bulb temperatures, rainfall, humidity and cloud cover are calculated. The average monthly and annual frequencies of specific weather occurrences i.e. thunder, fog, hail and snow are also included. Climatological Standard Normals for 1961 – 1990 are available and due to the high demand for the updated normals also 1981-2010.

Publications
- Technical papers;
- Series on general climate of South Africa (surface wind, temperature, precipitation etc.);
- Indigenous weather knowledge;
- Tornadoes;
- Educational units;
- Daily weather bulletin (inc. synoptic maps & data);
- Monthly summaries (incl. summary of significant events, rainfall & temperature maps, data etc)



Seasonal forecast (April-May-June 2013) for South Africa



Other services

- Statistical analyses of data (extreme values, windroses, maps etc.),
- Client specific project work,
- Specialized services to the legal and insurance industries,
- Advice to general public and to government organizations.

The SAWS-LRF group produces multi-model (MM) seasonal forecasts for precipitation, minimum and maximum temperature. Forecasts are produced on a monthly basis (for up to 6-month lead time). MM forecasts are obtained by downscaling model hindcasts from CFS (NCEP), CCAM (CSIR) and ECHAM4.5 AGCM to observed datasets. Forecasts of individual models are then averaged to produce MM forecasts (Landman & Beraki, 2010). SAWS-LRF group participates in SARCOF meetings to produce seasonal forecast for rainy seasons in SADC region. Each participating SADC member state produces forecasts for their own countries. Then consensus is reached by all to produce the SADC forecasts. LRF group also participates in other climate related workshops and conferences.

South Sudan

South Sudan lies between latitudes 3° and 13°N, and longitudes 24° and 36°E. It is covered with tropical forest, swamps, and grassland. The White Nile passes through the country. South Sudan is located near the Equator in the tropics much of its landscape consists of tropical rainforest, and its rich biodiversity includes lush savannas, swamplands and rainforests that are home to many species of wildlife. The climate of South Sudan varies but it is mainly tropical, similar to an equatorial or tropical climate, characterized by a rainy season of high humidity and large amounts of rainfall followed by a drier season. The most rainfall in South Sudan is between the months of April and October and the average yearly total is approximately 953 mm.

South Sudan Meteorological Service (SSMS) was formed on 9 July 2011 as a result of the independence. The young meteorological service is a governmental institution which falls under the Ministry of Transport. After the separation, the department of meteorology in the newborn Republic of South Sudan had to start from scratch, because all meteorological working instruments and weather forecasts were received from the pre-independence Republic of Sudan, but now South Sudan is starting to establish a weather forecast section in Juba.

South Sudan has 7 surface meteorological stations distributed as follow:

- Agromet station in Renk (Upper Nile State),
- Irrigation stations which included:
  -Raja, in Western Bhar El Ghazal State.
  -Bentiu in Unity State and.
  -Rumbek in Lakes State. .
- Synoptic stations

-Juba Met Station (Central Equatorial State).
-Malakal Met Station (Upper Nile State).and
-Wau Met Station (Western Bhar Ghezal State).

NWP products and other data used for weather analysis and interpretation:

- NOAA/COLA

- 850 hpa wind and humidity for day 1 and day 2
- 700 model analysis for vertical wind velocity
- Convective available potential energy (CAPE) and precipitable water
- Short term climate outlook for precipitation
- 700 hpa precipitation and vertical wind velocity
- Precipitation forecast outlook for 0-7 days

- ECMWF / UK MET-Office

- Regional map for precipitation forecasts
- Forecasts for different parameters

- EUMETSAT products

- Imagery in infrared channel, water vapour channel and visible channel

South Sudan was impacted by a number of severe weather and extreme events like rainstorms, strong wind, floods (1988, 1996, 2007) and droughts (1983, 1984, 1990, 2005, 2010).

Challenges

- Lack of essential meteorological communication networks to the regional distribution and international centers
- Lack of telecommunication links between the weather forecast section in Juba and meteorological offices in the states
- Difficulty in delivery of early warnings for disaster risk management needed by users
- Need to raise awareness among users on using and interpretation of weather information and warnings

Future plans

- Full establishment of National Meteorological Service
- Strengthen of database system
- Improvement the quality of weather products and services
- Establishment of upper air observation stations
- Channels for submitting forecasts and climatological information
- Installation of advanced technology for the dissemination and delivery of weather information and severe weather warnings via television, radio, mobile phones, websites and newspapers

Sudan

Sudan started weather observations as early as 1891 in Sawaken in the coastal area of the Red Sea. Most of our stations started observations during the period 1930 to 1940. During the 1980s the number of stations grew to 46 (of a range of purposes), as well as 2000 rain gauges. Due to the prolonged civil war the number of working stations decreased to 36 stations, while the number of rain gauges fell from 2000 to 300. This deterioration adversely affected network efficiency and forecast reliability. After the separation of South Sudan 28 stations remain.

Products

- 5-day and 10-day bulletins, monthly weather bulletin, climate normals and monthly and seasonal agro-meteorological monitoring bulletins
- Agrometeorological products: RFE, NDVI, Satellite

- Daily forecast
- Climate information products
- Seasonal forecast
- Numerical weather predictions
- All based on 1- to 3-hourly observations

SMA is currently adopting a project of rehabilitation in collaboration with the Finish Meteorological Institute (FMI), the objective is to modernized the SMA network by replacing the conventional observation system with an automatic weather observation system.

The benefits would be:

- Observations every 9 minutes
- Calculate other parameter fluxes automatically
- Easy communication with no lag time
- Supporting a number of data communication options and managing all communication protocols for the various sensors and other associated data communication equipment
- Providing the first level of quality control on both data measurement and message generation
- Allowing authorized users to access data remotely

The disadvantages would be:

- Limited area representation, an area of about 3-5 km around the sensor site
- More intense ongoing periodic routine maintenance
- Increased periodic testing and calibration
- Insure that a staff of well trained technicians and specialists is maintained
- Insure that a well trained staff of operators is maintained
- Resulting higher cost of instrumentation and operation. However, efficiencies gained through greater levels of automation may result in some cost benefits

Other Pilot Projects

- Climate Early Warning System in Sudan (proposed joint project with University of Reading) and rain watch (with Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), University of Oklahoma). The objectives are to develop an early warning system for pastoralist herders and farmers in three areas within Sudan (Darfur, Kassala and Blue Nile) and to understand the role of partnerships for successful early warning systems for improved food security in Sub-Saharan Africa.
- Africa Climate Exchange (AfClix) Boundary Organization. GIS near real time rainfall monitoring data will be used. SMA will provide 50 years rainfall daily data for at least 6 stations representing the country.
- SMA is adopting a QMS to get ISO9001/2008 Certificate for Aviation Services, which is recommended by ICAO and WMO.

Challenges and the way forward

- Analysis of historical extremes at different levels (station, zones and regional)
- Data rescue project
- Implementation of climate watch system
- Data policy and meteorological governance
- Orientation of training plans, topics and projects
- Investment initiations to develop and improve statistical and dynamical modeling

Swaziland

The National Meteorological Services of Swaziland was established in 1993, after the amalgamation of the meteorological service providers which existed then. The mission is to monitor weather and climate and to issue

advisories for safety of life and property while vigorously leading Swaziland to a low carbon emission path in its sustainable socio-economic development, taking into account regional and international initiatives and standards. The vision is to provide high quality weather and climate related services that are widely understood, available and easily accessible and greatly valued by all people of Swaziland and the world at large.
The NMS is comprised of three units: support, operations and advisory units. Climate data, observations, and long range forecasting fall under the advisory unit of the National Meteorological Services of Swaziland. Climate monitoring will fall under this unit once in place.
Swazi Met maintains a network of eleven climatological stations. 5 of these stations are fully manned and maintained by Swazi Met. The rest are run by research/academic institutions with assistance from the Swazi Meteorological Service. From these climate stations, the advisory section is able to receive daily maximum and minimum temperatures, rainfall, wind speed and directions. 20 rainfall stations, which are volunteer stations, provide the Met Service with daily rainfall amounts. 15 Automatic Weather Stations (AWS) transmit hourly data to the head office. The climate data generated from the land stations is transmitted either telephonically on a daily basis to the head office or sent through mail as monthly reports. We also have a lightning sensor which covers the whole country and is linked to the regional hub in Pretoria. This allows us to issue lightning warnings.
Clisys (a Climate Data Management System developed by Meteo France) is used and provides a set of tools and procedures that allow all data relevant to climate studies to be properly stored and managed.

Three tools are used in the preparation of long range forecasts for SARCOF:

- Plato IDE is used to locate the basins with high correlation of Sea Surface Temperatures (SST's),
- Grads which is used for extraction of the SST's from the sea basins,
- Systat which is used for the regression model

The unit is headed by a WMO class 1 meteorologist. The long range forecasting is done by a WMO class 2 meteorological technician. Data base management is a responsibility of a WMO class II meteorological technician. Meteorological observations are carried out by WMO class III and IV technicians in those stations that are fully maintained by the National Meteorological Services of Swaziland. For the rainfall volunteer stations, the data is handled by non-experts but is subjected to some vigorous quality control measures before it can be put to use.
The department carries out regional workshops together with the Ministry of Agriculture after the issuing of each seasonal forecast, sensitizing farmers on the importance and the use of the forecast for planning. The department also works hand in hand with the National Malaria Control Unit under the Ministry of Health by providing them with seasonal forecasts so they are able to know areas likely to have a scourge of mosquitoes and are able to plan their mitigation strategies.
The disaster management services is also a part of our advisories to clients as they are continuously advised on areas likely to be affected by extreme weather, e.g. lightning prone areas, flooding prone areas, areas likely to experience heat waves, etc.
The Central Forecast Office issues public warnings in case there is likelihood of extreme weather. These warnings are usually issued through the media and the Swazimet website. They are always accompanied by mitigation procedures whenever they are issued. There is also a SMS service where relevant stakeholders are notified should there be a climate advisory generated by Meteofactory. In addition to all of the above, the department regularly conducts schools visits, and radio and television shows where the public is advised on issues of climate change.

Specific issues

Sometimes the long range forecasts is requested long before the experts in the region have met and issued it (before SARCOF). The duration of the seasonal forecast preparation is short. Experts sometimes work until midnight during those sessions. The temperature forecasts are not included in the preparation of the long range forecast yet although end users are interested in knowing them.

Challenges

There is a lack of manpower due to the fiscal difficulties our Government was facing in the last few years. We have not been able to adequately man all our weather stations. Since our stations are insufficiently manned, we have difficulty in having observations carried out over the weekends. We also have a shortage of skills to effectively manage our database systems. We frequently encounter problems with Clisys, which with proper staff training and skill transfer could be solved. AWS's are breaking down frequently. They are not fixed in time; hence we have non-continuous data sets. An intranet is linking stations to the main server. Officers in these stations will be able take care of preliminary data processing and key entry. Recruitment permission has been requested from Government.

Tanzania

The National Meteorological Services were provided under the Directorate of Meteorology (DoM), established by Act No. 6 of 1978 after the demise of the East African Meteorological Department. Tanzania Meteorological Agency (TMA) was formed by the Executive Agency Act no. 30 of 1997 under the Ministry of Transport. The Agency came into being on 3 December 1999.

Vision: To stand out as the center of excellence in accelerating the National Development Vision through provision of world class meteorological services by the year 2015.

Mission: To provide quality, reliable, and cost effective weather and climate services to stakeholders' expectations, thus contributing to the protection of life, property and environment and poverty reduction.

Functions:
- To provide weather, climate services and warnings (e.g. floods or droughts) for the safety of life and property to the general public;
- To provide weather and climate services to various users including agriculture and food security;
- To provide weather and climate services to various users including surface transport;
- To provide meteorological services for local and international air navigation on behalf of the United Republic of Tanzania as the designated meteorological authority and according to Technical Regulations of the World Meteorological Organization Doc. ([C.31] 2.1.4) and Annex 3 (2.1.4) of the International Civil Aviation Organization;
- To take part in global exchange of meteorological and related data and products for the safety of human kind and to enhance the understanding of the global atmosphere

TMA is a custodian of climate data for Tanzania and maintains 26 synoptic stations with more than 30 years of data (rainfall, temperature, humidity, wind etc.) which are archived in paper forms and digital forms. CLIDATA is the current DBMS.
TMA has developed a five-year plan to modernize and expand the existing surface and upper air observation network stations necessary to capture accurate records of the weather and climatic conditions of the United Republic of Tanzania for the meaningful addressing of changing climate.

- A severe desk was established focusing on Lake Victoria
- Short and medium range forecasts are issued
- Severe weather for mobile phone users; Starfish mobile through Vodacom-Tanzania warn Farmer through Tigo-Tanzania (on test phase)
- Severe Weather and Medium Range Weather Forecast (SEMERAWF) desk in collaboration with RSMC-Nairobi and UKMET OFFICE through SWFDP-EA project has started weather analysis using "audio-visual teleconference"

In collaboration with Regional Centres (ICPAC, CSC-SADC) the following methods are used:
- Statistical
- Dynamical

- Indigenous knowledge
- Analogous years (Global Oceans and atmospheric condition; e.g SSTs and winds)

Three phases of the development of seasonal climate outlook in Tanzania:

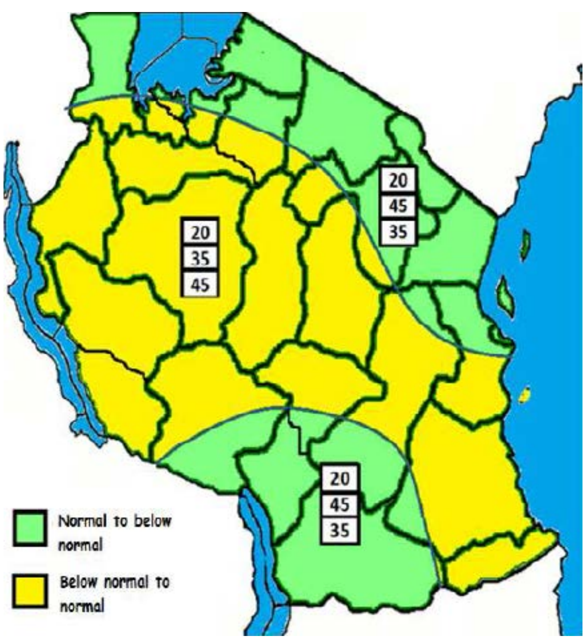
1. TMA scientists work for some days to develop a preliminary seasonal climate outlook for the country.
2. Involvement of Regional Climate Outlook Fora (COF) based in SADC and IGAD regional centers.
3. Downscaling of regional seasonal climate outlook to national level by TMA scientists taking into consideration the results from the preliminary forecast and micro-climatic features in various climatological zones.

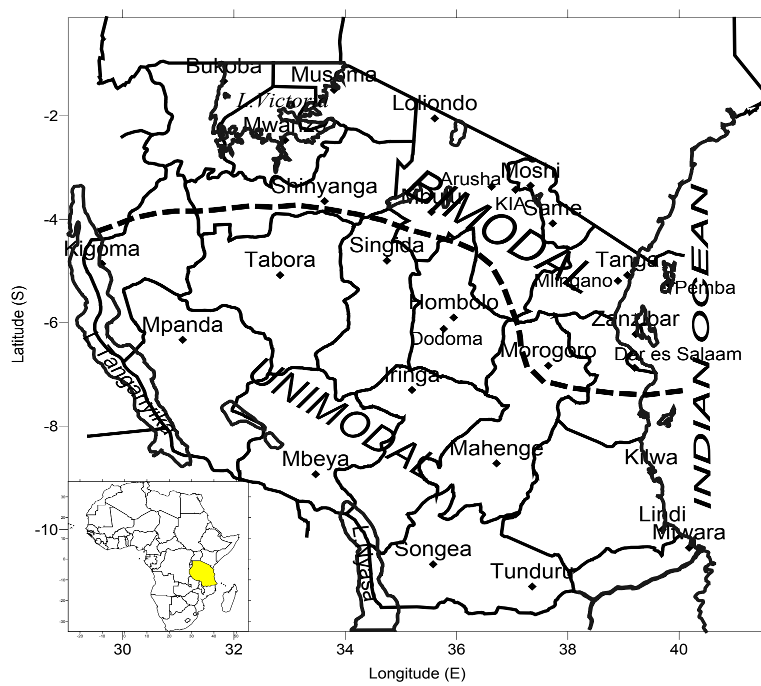
After the final forecast is produced, TMA interacts with various socio-economic sectors in the country including water, health and agriculture, tourism, disaster reduction, energy and media among others. TMA uses television, radio, blogs, newspapers, journals, mobile phones and social networks such as Facebook, Twitter and Youtube to reach the population. Example of advisories are given on www.meteo.go.tz and www.wamis.org. Feedback from clients shows that 75% are satisfied with TMA services.

In recognition of the important role of Numerical Weather Predictions (NWP) in predicting severe weather and extreme events in the context of climate change, TMA established a NWP unit. A computer cluster has been procured and is about to start working. However there is a need of capacity building. For effective research in climate change and variability, TMA through the climatological and climate change section, is trying to digitize and archive the long term climatological data currently in paper form. TMA collaborate with other research institutions in the country and internationally, such as Sokoine University of Agriculture (SUA), University of Dar es Salaam (UDSM), Ardhi University (in Tanzania) and some universities in Norway and South Africa in the field of climate change and variability research. TMA has been in the forefront to raise climate change and variability awareness with policy makers, students and public.

Problems/Challenges/Priotity needs:

- Inadequate stations network
- Modernization of instruments owned by TMA (most modern meteorological equipments and instruments are very expensive)
- Inadequate funds to conduct research in climate change and other related areas
- Link between IK and conventional weather forecasting to cover the entire country





- Transferring of AWS data to the central database and training on AWS data handling
- Funds for training of staff
- Increased number of staff in various operational areas
- Need for own building for TMA headquarters and Central Forecast Office which can host meteorological instruments and other operations
- Funds to rescue and digitize historical climatic data in deteriorating paper forms
- Dissemination of our products which include raising awareness to users in various levels (up to lowest) and decision makers.

Despite the challenges, TMA is striving to achieve the highest quality of services to the local and international community.

Uganda

Mandate: To promote and monitor weather and climate and provide weather forecasts and advisories to Government and other stakeholders for use in sustainable development of the country.

As natural resources are diminishing with increased population pressure, it is becoming increasingly important to utilize weather and climate information in planning. Due to increased climate change and variability, weather information is the key to future adaptation and mitigation measures which the country will have to adopt to survive. The Station Network Division is responsible for the design of an optimal network system, and implementation and monitoring of the networks (12 synoptic stations, 12 hydrometeorological stations, 10 agrometeorological stations, 300 rainfall stations, 1 upper air station). The data processing software used are CLICOM and ClimSoft. Data rescue efforts are ongoing. Therefore a data lab was established with 10 new computers and a main server. The digitisation is ongoing for manned observations.
Seasonal climate outlook plus monthly reviews and updates, agro-meteorological bulletins on 10-day basis are issued. Climatological data for different users and clients and user tailored information mainly for construction and insurance companies are provided.

In Uganda climate related disasters are mainly associated with seasonal rainfall extremes resulting in droughts and in situations of enhanced rainfall, floods and landslides. Extremes annually destroy an average of 800,000 hectares of crops leading to huge economic losses especially among poor communities. Droughts also result in epidemic outbreaks and climate related conflicts.

Key activities
- Continuous support for IGAD Climate Prediction and Application Centre (ICPAC) in preparation of seasonal forecasts during PRE-COFs and COFs. Regional hub for access to climate products and data from international forecast centres
- Support from NOAA for training two staff in Numerical Weather Prediction and a work station for running the WRF Model for short range forecasting.

Delineation of homogenous rainfall zones
Principal Component Analysis (PCA), derived from Factor Analysis is a statistical technique used in identifying a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables. This method has widely been used in determining regional homogeneous rainfall zones over East Africa. Predictors are climate indicators used for seasonal monitoring and prediction. In case of Uganda's climate they include:
- SST: (SSTs and SST Gradients, Indian Ocean Dipole): Reconstructed sea surface temperature (SST)
- dataset from Climate Prediction Center (CPC) of NOAA
- Quasi-Biennial Oscillation (QBO)

- Madden Julian Oscillation (MJO)
- Southern Oscillation Index

Downscaling

- Interpretation and downscaling of the seasonal climate forecasts is done at national level
- Seasonal post-COF stakeholder workshop is hold to develop advisories based on downscaled forecast
- Translation of the current seasonal forecast into seven local languages. Audio and text translations are disseminated using community FM radios and local language print media. This initiative was done for the last 3 seasonal forecasts.
- Assessment of forecast performance

Selected observed extremes during MAM 2013 season:

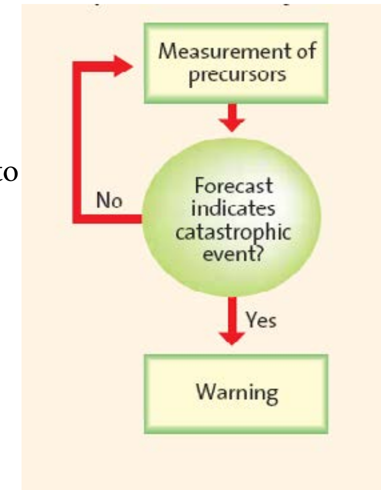
- Butaleja District (Eastern Uganda) on 13 March 2013 experienced heavy rains, accompanied by hailstorms and strong winds. In less than an hour, 40 houses had their roofs removed, while many crop fields were destroyed and a 7 year boy was killed by collapsing walls.
- On 30 March, a heavy storm hit Ntoroko Landing Site (western Uganda), leaving more than 40 houses destroyed, including a school and three churches.
- A tornado-like storm hit an island on Lake Victoria. Nearly half the inhabitants of Lujjabwa Island on Lake Victoria were rendered homeless after a powerful storm descended from the clouds and swept over 75 shelters into the lake in early morning of Thursday 14th March.
- Floods ravage Kisoro (SW Uganda), over 150 families were displaced. Several houses were destroyed while community roads were eroded by the floods rendering them impassable on Sunday 31 March.

The People-centered Early Warning System

A good EWS should be an integrated part of planning as a program designed to mitigate and respond to the disaster. The aim is to empower individuals and communities threatened by hazards to act in sufficient time and in appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment.

Challenges facing EWS:

- Different hazards require different early warning systems
- Effective communication with communities
- Information fatigue
- Links between analysis and action (particularly between technical capacity to issue the warning and the public capacity to respond effectively to warning)
- Accuracy and reliability of information
- Coverage and timeliness
- Political sensitivity
- Decentralization and local responsibility



Developing and implementing an effective early warning system requires the contribution and coordination of a wide range of individuals and institutions.
Each has a particular function for which it should be responsible and accountable. Therefore, in the case of Uganda:

1. We need to understand the roles and responsibilities of:

- Communities
- Local governments
- Central government
- Regional institutions and organizations
- International agencies
- Non-governmental organizations
- The private sector
- The science community

2. How should the coordination body for early warning system be constituted? Who should be the members?

Conclusion:
The occurrence of disasters related to extreme weather events cannot be stopped, therefore timely availability and application of accurate meteorological information would assist in making contingency plans thus avoiding crisis management in responding to these disasters. There is need to improve monitoring and observations, modelling, prediction and early warning capacities; timely availability of data and information; databases for development of drought and flood indices; vulnerability assessment under different environmental conditions; skilled human resources, education, sensitisation and awareness

Zimbabwe

One of the Meteorological Services Department's (MSD) prime functions is the measurement and collection of accurate weather records whose main purpose is to contribute to the safety, security and general welfare of the Zimbabwean community through performance of meteorological functions. It is also responsible for the collection and long-term custody of reliable meteorological and climate data in fulfillment of the country's and international obligations.
Over 70% of Zimbabwe's population's livelihood depends on agriculture and more than 10 million people directly benefit from agriculture and sub-sectors related to it. Yet weather and climate are still the key factors in agricultural productivity in Zimbabwe.
There is a need to increase the accuracy of the provision of weather forecasts, warnings, information and advisories for the general public and most major sectors of the society, including agriculture, aviation, tourism, environmental management and natural disaster mitigation.
Zimbabwe maintains 47 manual synoptic stations manned by meteorological personnel, 17 part-time manual synoptic stations manned by Agriculture Extension Officers and approximately 300 rainfall stations (voluntary).

The strategic plan is to install 150 AWSs by 2015, to decentralize data capturing and to enter into sustainable partnerships.
The sparse observation network that provides input to NWP models is a cause for concern as it affects quality of forecasts. The exact timing of events is not known. In addition, if farmers do not understand the forecast (probabilistic terms), they may ignore it or use it wrongly thereby making wrong decisions. Also, the forecast is not useful if it comes when farmers have already planted or purchased certain seed varieties. Some technical terms are also difficult to translate into local languages.

- Credibility:

If previous forecasts were viewed as "wrong", people will not believe subsequent forecasts.

- Communication channels used:

Certain media (print or electronic) are not appropriate for certain communities.

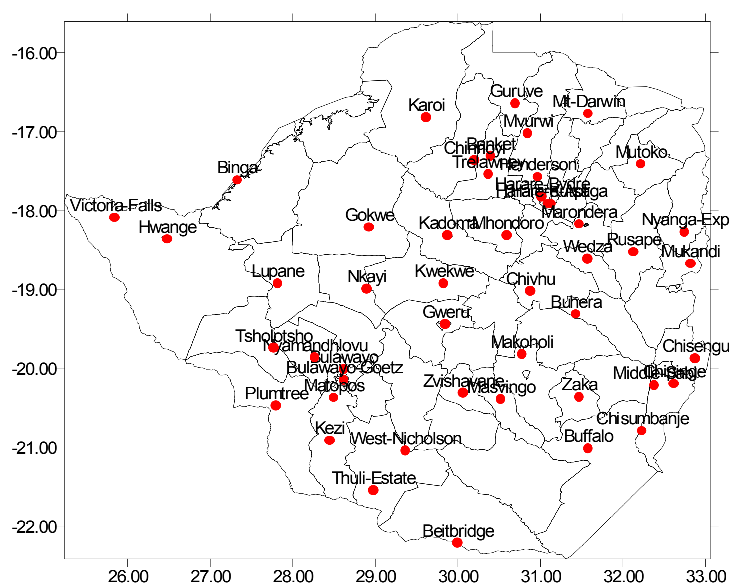
- Scale:

Farmers require a more localized seasonal climate forecast but current advances in seasonal climate forecasts only provides generalized regional climate information relevant to seasonal time scales and relatively large areas. Farmers fail to take advantage of a favorable forecast.

The existence of an early warning mechanism involves the Meteorological Services Department and the Civil Protection organisation in Zimbabwe. The Ministry of Local Government, Rural and Urban Development (Department of Civil Protection) plays the coordinating role in DRR activities.

Regional collaborations:

- SADC-CSC
- Many Disaster Risk Reduction and adaptation projects are currently being driven by the Governments and local and international NGOs. NGO's and self-help groups have started initiatives to reduce vulnerability to drought.
- Rehabilitation, better land-use planning and building regulation at the community level
- Integration of DRR into the education system of the country
- Local (affected) communities have a much bigger role to play. As a result, they are involved in planning. They are the custodians of local coping strategies (Indigenous Knowledge Systems) that can be used as initial early warning and response mechanisms.
- Vulnerable communities are being capacitated in DRR activities



Session-IV: Hands on practical session on submission of annual and decadal global climate summaries

Blair Trewin (BoM) informed the audience about the WMO statement on the status of the global climate. Two statements are issued each year. A preliminary statement is issued in late November/early December (normally using data to end of October) and a final statement is issued on World Meteorological Day (23 March or the weekday closest to it). The statement is coordinated by an expert from an NMHS. This position rotates between WMO regions every 2 years.

Key elements

- Global temperature anomalies and ranking
- Notable regional/national temperature and precipitation anomalies
- Major extreme events (e.g. drought, flood, tropical cyclones, severe storms, extreme heat/cold)
- Status of key climate drivers (e.g. ENSO)
- Sea ice
- Ozone

Derivation of global mean temperature

- Uses an average of three major global data sets (NCDC, HadCRU, GISS)
- All data sets rebased to anomalies from 1961-90 normals

Information sources

- Requests for input from Members (formal and informal)
- Published climate monitoring products (e.g. seasonal and annual summaries) on NMHS and RCC web sites
- Global centres (e.g. NCDC, GPCC, Hadley Centre, JTWC, NSIDC)
- 'Raw' data (e.g. CLIMAT, synoptic data)
- Remotely sensed products

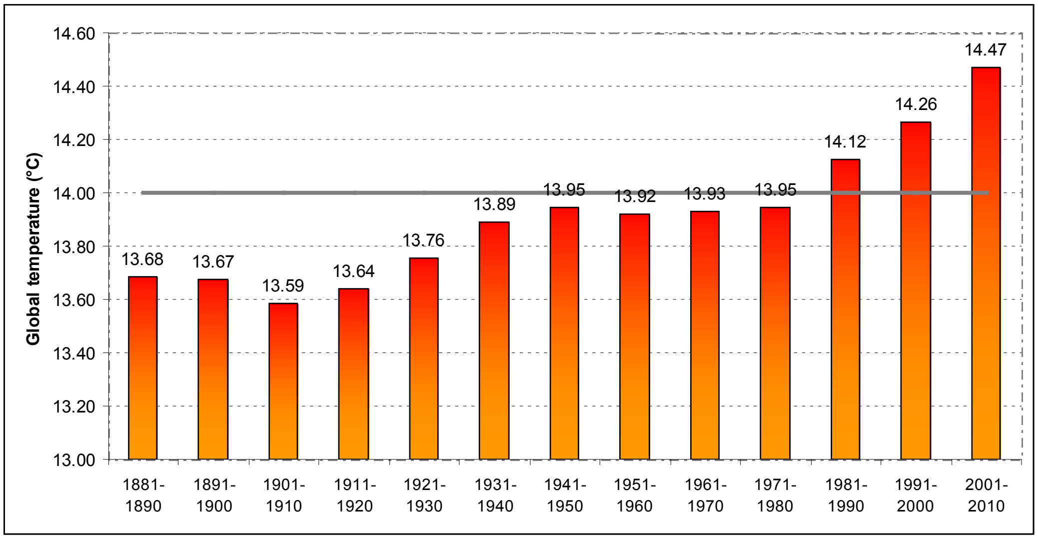
Major challenges

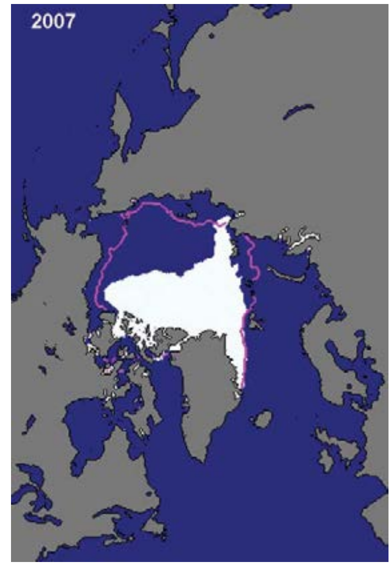
- Large parts of the world have little or no national-level information available, so WMO has to fall back on global or remotely-sensed data sets
- Locally published information sometimes hard to find – automatic translation good once a document is found, not so good for finding document in first place
- Continental temperature anomalies are not routinely reported by anyone
- In some cases (e.g. global temperature, sea ice) there are multiple data sets which can give different results

Useful information provided by NHMSs

- Ranking for the country/regions/specific locations (especially places which have set temperature or precipitation records)
- National input critical for confirming (or not confirming) extremes
- Difficult to obtain good information on impacts – WMO will only use 'officially sourced' information

Karolin Eichler (WMO) informed before the hands-on session about the Guide to Climatological Practices and Decadal Global Climate Summary. In addition to the WMO annual statements on the status of the global climate (produced regularly since 1993) WMO produced, in 2003, a six year Climate Review covering 1996-2001. The main content was based on the annual State of the Climate reports which are published by NCDC in the Bulletin of the American Meteorological Society. In 2005, CCl agreed to publish a five year climate summary to complement the WMO annual statements. Due to the lack of resources WMO decided to produce a decadal climate summary





covering 2001-2010

The publication coincides with the first decade of the twenty first century and aims to provide a decadal perspective of climate variability and change while assessing the current climate knowledge at global, regional and national levels. The decade 2001-2010 was characterized by a record in global temperature increase since sufficiently comprehensive global surface temperature measurement began in 1850. For global land-surface air temperatures as well as for ocean-surface temperatures this decade was the warmest on record. This trend is confirmed at national level where 94% of the countries had their warmest decade in 2001 to 2010 and 6% in 1991 to 2000. The rate of temperature increase was particularly high in the northern hemisphere. Flooding was reported by a great majority of countries as the most frequent extreme event during the last decade followed by droughts, heat waves, heavy rainfalls and severe storms. Consistent with the conclusions of the recent IPCC Special Report on Extremes, fewer minimum temperature records and more maximum temperature records were broken during 2001 – 2010 than in earlier decades.

The decade saw two unprecedented heat waves in Western Europe in 2003 and Russia in 2010 with many associated fatalities and other severe health impacts. The decade also saw the most costly Atlantic hurricane, Katrina, in 2005, and major flooding in Pakistan in 2010 with more than twenty million people affected. Many other extremes were also experienced elsewhere in the world.

Increases of the atmospheric content of greenhouse gases due to anthropogenic activities are recognized by IPCC as the key driving factors of the observed climate change. CO_2 mixing ratio continued to increase through the decade, with a rate higher than in the previous decade, reaching 389 ppm by the end of the decade. This value is the highest recorded for at least 10000 years and it is 39% higher than the mixing ratio at the beginning of the industrial era (1750). The dramatic and continuing sea ice decline in the Arctic is one of the most prominent features of the changing state of the climate during the decade with the five lowest minimum sea ice extents at the end of the melting season all recorded in the second half of the decade with the record set in 2007.

In the Guide to Climatological Practices it is stated that Climate Normals are used for two principal purposes. They serve as a benchmark against which recent or current observations can be compared and they are widely used as an implicit prediction of the conditions most likely to be experienced in a given location. Under the WMO Technical Regulations, climatological standard normals are averages of climatological data computed for the following consecutive periods of 30 years: 1 January 1901 to 31 December 1930, 1 January 1931 to 31 December 1960, and so forth.

- As far as possible, the data used in the calculation of climate normals and averages should be homogeneous.
- Climate normals and averages should be calculated for as many stations as possible if it meets standards for the amount and completeness of available data. As a minimum, they should be calculated, if possible,

for all stations whose data are distributed on the Global Telecommunication System
- As a guide, normals or period averages should be calculated only when values are available for at least 80 per cent of the years of record, with no more than three consecutive missing years. An alternative option, when there is an extended period of missing data but reasonably complete data after that time, is to calculate a period average using only data from the years following the break in the record.
- Annual normals or averages should be calculated as the mean or sum of the 12 monthly normals or averages, without consideration of the varying lengths of the months. No missing monthly normals are permitted in the calculation.
- It is recommended that a monthly value should not be calculated if more than ten daily values or five or more consecutive daily values are missing. In the case of elements for which the monthly value is a sum of daily values rather than a mean, a monthly value should be calculated only if either all daily observations are available, or if any missing days are incorporated in an observation accumulated over the period of missing data on the day when observations resume.
- The best statistical approximation of a daily temperature average is based on the integration of continuous observations over a period of time; the higher the frequency of observations, the more accurate the average.
- All ordinary climatological stations observe a daily maximum and minimum temperature. Hence, the recommended methodology for calculating average daily temperature is to take the mean of the daily maximum and minimum temperatures. Even though this method is not the best statistical approximation, its consistent use satisfies the comparative purpose of normals.

After the general introduction of Karolin Eichler, country-specific questions of the participants concerning their national data for the decadal global climate summary were discussed during the hands-on session, especially concerning format, missing data, reference periods etc.

Session-V: Parallel Working Group session

Goal of the break-out group discussions

Whilst the overall goal of the workshop was to facilitate the implementation of a climate watch system in the southern and eastern part of RA I, the task of the break-out groups was to address the following aspects in more detail:

Break-out group 1:	Format, content and dissemination of (national) climate advisories
Break-out group 2:	Different aspects of (national) climate advisories including user involvement
Break-out group 3:	Basic infrastructure requirements and needs for (national) climate watch implementation including the role of the regional centers and capacity building

The break-out groups were expected to help specifying, how different components of a RA I (in particular southern and eastern Africa) Climate Watch System should look like and identify necessary steps towards its implementation. The break-out groups were expected to report back to the plenary.

Some seeding questions for break-out group 1:
Format, content and dissemination of (national) climate advisories

1. Is on of the examples of a climate watch advisory as given sufficient for RA I (south and east) purposes?
2. Which issues are relevant to the format, content, dissemination and verification of (national) climate watches in RA I (south and east)?
3. How to define criteria for issuing, updating and ending a climate watch advisory?
4. How to verify climate watch advisories and how to monitor and improve the system?

Some seeding questions for break-out group 2:
Different aspects of (national) climate advisories including user involvement and research

1. Who are potential user groups for national climate watch advisories in RA I?
2. How to compile and update relevant user requirements for national climate watch advisories?
3. How to liaise with (potential) users of national climate watch advisories?
4. How to access and handle socio-economic data to understand impacts of climate watch advisories on user decision processes?
5. Is there a need for regional climate watch advisories?
6. How to best communicate and disseminate climate watches to the users?
7. Which research and development aspects need to be tackled and resolved in order to provide ideal climate watch advisories in RA I (south and east)?
8. How to facilitate the information exchange amongst NMHSs on climate watch practices and experiences?

Some seeding questions for break-out group 3:
Basic infrastructure requirements and needs for (national) climate watch implementation including the role of the regional centers and capacity building

1. Why do we need a Climate Watch System in southern and eastern RA I and what are the system requirements?
2. Which sources of climate data and climate information (including monitoring and prediction methodologies, tools and products) are available to enable NMHSs to issue national climate watch advisories?
3. Which guidance products (including timing) and tools are needed from global and regional institutions and mechanisms, such as GPCs, RCCs, RCOFs etc., to enable NMHSs in RA I to issue national climate watch advisories?
4. How to make best use of existing capabilities at national and regional level, including GPCs, RA I (south and

east) RCC-Network, etc.?
5. Which are the specific requirements for NMHSs to implement climate watch systems at national level?
6. What kind of capacity building requirements are involved in the implementation of a climate watch system in RA I (focus on national level, such as infrastructure/equipment, staff resources, training etc.)?
7. How to mobilize resources and how to attract sponsors to assist in capacity building for fully implementing a climate watch system in RA I (south and east)?

Session VI: Presentations of the WGs conclusions (see beginning of the document)

The outcome of the WGs resulted in a number of actions and recommendations, which are summarized on page 7 of this document. Recommendations consist of several requirements concerning format, content and dissemination of national climate advisories, but also data, research, capacity building, improvement of infrastructure and collaboration of national and international institutions.

First important steps for implementation of Climate Watches within the first year will be to identify user groups and their needs and to start a CWS trial period to gain some experience. Support of WMO RCCs would be appreciated for the implementation process, therefore the establishment of further WMO RCCs should be promoted.

Closure of the workshop

Karolin Eichler thanked all the participants for their valuable inputs to the discussion. She also thanked the host for the very efficient arrangements to facilitate the meeting as well as the warm hospitality. The host thanked the participants for their dedication and WMO for its support and assistance. He expressed his hope for an early implementation of the Climate Watch System and wished the participants a safe return.

The workshop was closed on Thursday, 18 April 2013 at 12 hours.

For more information, please contact:

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